DESIGN IMPROVEMENTS IN THE RECREATION SUPPLY AND DEMAND ANALYSES FOR THE 1990 RPA ASSESSMENT

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INTRODUCTION

The legislative foundation of the long range planning and management of the United States Forest Service (FS) is found in the Multiple Use - Sustained Yield Act (MUSYA) (U.S. Congress, 1960), the Forest and Rangeland Renewable Resources Planning Act (RPA) (U.S. Congress, 1974), and the National Forest Management Act (NFMA) (U.S. Congress, 1976).

The requirement in the RPA to which this work is directed is:

> (1) an analysis of present and anticipated uses, demand for, and supply of the renewable resources, with consideration of the international resource situation, and an emphasis of pertinent supply and demand and price relationship trends. (Sec. 2)

This study is limited to only one of the renewable resources produced on FS lands--Outdoor Recreation Resources, and it is not oriented towards international resource considerations.

Within the "demand analysis," projections are called for which will be useful in developing FS plans, especially the 1980 RPA Program. The foundation of this requirement for projected future consumption is found in the definition of Multiple Use in the MUSYA:

> the management of all the various renewable surface resources of the national forests so that they are utilized in the combination that will best meet the needs of the American people. (Sec. 4)

And, this is re-stated in the NFMA as:

> the Forest Service. . . has both a responsibility and an opportunity to be a leader in assuring that the Nation maintains a natural resource conservation posture that will meet the requirements of our people in perpetuity. (Sec. 2)

Thus, development of projections of these "uses", "needs", or "requirements" is clearly paramount in fulfilling the legislative requirement to which this project is directed.

The demand analysis called for clearly involves more than projection, however. In the MUSYA (again, in the definition of Multiple Use) the FS is called upon to practice:

> management . . . with consideration being given to the relative values of the various resources, and not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output. (Sec. 4)

And, in the RPA the FS is required to develop:

> specific identification of Program outputs, results anticipated, benefits associated with investments in such a manner that the anticipated costs can be directly compared with the total related benefits and direct and indirect returns to the Federal Government. (Sec. 3)

Thus, it appears that the demand analysis called for should include some valuation (estimation of value indexes) of the renewable resources to be considered. Furthermore, it is clear that one intent of the new Regulations for Land and Resource Management Planning in the National Forest System is to require economic efficiency analysis in all Forest System plans. And, this efficiency analysis will involve some sort of applied welfare economics methodology such as benefit-cost analysis.

Within the "supply analysis", two types of approaches are also called for. First, to go along with the "use projections", present facilities need to be inventoried in terms of capacity. Projections of this capacity under different assumptions concerning Forest Service area development have been employed to indicate future consequences of those different assumptions. This approach is described in the RPA requirements as:

> (2) an inventory, based on information developed by the Forest Service and other Federal agencies, of present and potential renewable resources, and an evaluation of opportunities for improving their yield of tangible and intangible goods and servies, together with estimates of investment costs and direct and indirect returns to the Federal Government. (Sec. 2)

Second, to go along with the value or benefit estimation in the "demand analysis", a cost estimate is also necessary to complete benefit-cost analysis (or its equivalent). In this approach, the supply analysis essentially amounts to determination of a marginal cost curve which will serve as a supply curve surrogate.

It is important to maintain this distinction between the two approaches. The use and inventory analysis is useful in determining and foreseeing large scale congestion or excess capacity in recreation areas. The benefit and cost analysis is useful in determining economic efficiency.* The purpose of this paper is to suggest improved analytical procedures for both of these approaches. The primary focus of this report is on the demand side, so supply considerations will be discussed within the contexts of the participation projections and the benefit estimations.

The participation projections will be discussed first, followed by benefit estimation. Following these two sections, an operations research model structure will be presented that can simultaneously analyze cost and benefit information in a regional recreation planning context, and arrive at an efficient selection of recreation alternatives. Finally, the manner in which these various procedures can fit into the structure of Forest Service

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*See Hof (1979) for more discussion on the distinction between these two approaches.

planning will be discussed. It is hoped that all this material will serve as a detailed study plan for future analysis, even though it is not presented in a typical study plan format.

THE METHODOLOGY OF OUTDOOR RECREATION PARTICIPATION PROJECTION

It has been postulated that the purpose of the recreation participation projections calaculated in this study is not that of creating an economically efficient allocation of forest resources, but simply that of anticipating large scale over-use or congestion of future recreation resources. The participation projections should thus be in terms of actual consumption levels to be expected, given future costs of consumption, supplies of recreation opportunities, and other demand shifter values. If outdoor recreation resources were, in general, cleared in a market system, then the actual consumption level to be expected would be an equilibrium quantity demanded, and the appropriate projection model would be a simultaneous set of two equations--a supply function and a demand function. Even though some recreation resources are market goods, and still others are mixed public/private goods, it will be assumed that the outdoor recreation resources analyzed here are predominantly provided through the public sector, and are thus not subject to market equilibrating forces. Thus, future consumption levels are indicated to be determined by a combination of supply and demand pressures, and the appropriate projection model should be based on the following structure:

$$Q_c = f(P, X_i, Q_p)$$

Where:

Q_c = the quantity of recreation resources actually consumed

Q_p = the quantity of recreation resources provided by the public sector

X_i = the traditional "demand shifters"

P = price surrogate.

The consumption function in this structure has as its arguments: a non-competitive price surrogate, such as travel costs, and an index of the aggregate quantity supplied which is determined independently. In addition to these arguments which do not normally appear in a demand function, the consumption function also includes the traditional demand shifters--income, prices of complements and substitutes (as can be included), and taste and preference indicators (King, 1968).

The preceding discussion, then, indicates that the general approach to be taken in projecting recreation participation should be to identify the participation function, and apply projections of the arguments of that function in order to arrive at expected future participation levels.* This was the appraoch taken in the analyses for both the 1975 and the 1980 Assessment. This basic approach appears to be the best available at this time. In order to suggest improvements, the methodology employed for the 1980 Assessment will quickly be reviewed, followed by a discussion of its weaknesses, and how these might be ameliorated.

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*A simpler alternative would be to extend the recent trend in participation into the future. This simple approach is rejected for two reasons: 1) such an approach relies on the additional assumption that trends in all determinants of participation will remain constant in the future, and 2) it is useful to know not only the magnitude of a participation projection, but also the reasons for that projection being the way that it is. If the trend in one of the arguments of the participation function should unexpectedly change in the near future, the importance of that event would be unknown with nothing but a simple time-trend of participation available.

The Methodology Previously Employed

The basic methodology used to project the number of participants in specific activities in the Nation can be described in three steps.

Step 1 - First, predictive equations were derived which relate a set of explanatory variables to the probability that the average American will participate in the given activity. These equations were regressed using the data collected in the 1977 National Recreation Telephone Survey carried out by the Heritage, Conservation, and Recreation Service (HCRS). The dependent variable in each equation (one equation for each activity) was a 0-1 variable representing participation (1) or non-participation (0).* The explanatory variables taken from the survey for each respondent are: type of residence (urban, rural, or suburban), age, years of education, race, length of work week, number of vacation days per year, family income, sex, and number of "close-proximity" parks. In addition, a set of supply availability indexes was attached geographically to each respondent. Also, a "price" term was assumed for each activity. This was necessary since no consumption cost information was included in the survey (nor could it be geographically attached).

Step 2 - Second, it was necessary to project the explanatory variables used in the equations derived in Step 1. This was

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*This type of equation is equivalent to the first-step "conditional probability" equation suggested by Cichetti (1969, 1973) and originally discussed by Goldberger (1964).

accomplished by observing recent trends in these variables (see Hof, 1979, for more specifics).

Step 3 - Third, the regression equations and the independent variable projections were used to project participation. This was accomplished by substituting expected future independent variable values into the regression equation to arrive at the percent of the future population that is expected to participate in the given activities. Then, the number of participants was projected by applying these percents to the population projections.

Weaknesses in the Methodology and Suggested Design Improvements

Dependent Variable Unit of Measure

As was previously indicated, the unit of measure used for the participation projections was merely the number of participants in the given year, in the given activity. This unit, then, ignores the frequency of participation and the duration of participation. This unit was employed because the data set used contained no additional information. Even had the HCRS survey collected more information, however, the "proper" unit or measure is not clearly defined. Other units of measure which are commonly used include visitor days and number of trips. The first of these includes, indirectly, the frequency of participation as well as duration of participation over whatever time period (such as a year) employed. The second indicates only the frequency of participation, with no information included concerning the duration of any given trip.

It would seem that we wish to measure the number of "experiences" that are consumed (or are expected to be consumed). And, it would seem that "experiences" are a commodity that is neither continuously devisable, nor, homogenously defined among various consumers. "Trips" would probably come as close to measuring "experiences" as is presently possible. Returning to the FS problem, however, the FS choice variable is the amount of the recreation resource that should be produced. In order to relate projections of "experiences" to needed FS recreation resources, information concerning the length of those trips might also be necessary.

The value of all future participation (and for that matter, valuation) analyses depends heavily on a more precise, well-defined, and theoretically tenable unit of measure for recreation consumption activities. At this time, "trips" not only seems to be most closely related to "numbers of experiences," it is also considered more reliable -- it is easier to determine how many times a person participated than it is to determine how long he participated. At any rate, the number of participants is clearly an inadequate unit of measure, and data sources which allow more sophisticated measurement should be constructed if at all possible.

Work by Driver and Brown (1975) using psychological desires of participants shows considerable promise in developing definitions of these consumption activities and their appropriate units of measure. This will be discussed below, concerning benefit estimation.

Measurement Errors

Measurement errors may exist in any national recreation survey from a number of sources, such as: respondents misunderstanding the questions,

respondents intentionally responding falsely because of some interest or other bias, sampling errors, and so forth. Kmenta (1971) discusses "Errors of Measurement" and concludes that, even if the measurement errors are independent, random, normally distributed, and have a mean of zero, the least squares estimates of both the slope term and intercept term are inconsistent. That is, the estimators are biased, the statistical tests are invalid, and increases in the sample size will not, in itself, improve the situation. The magnitude of this problem cannot be estimated; however, its potential impact should be remembered in the design of all future analyses. A set of consistent surveys taken at different times, or a "time-diary" survey might increase reliability and testability of that reliability.*

Constancy of Relationships

As has been identified in a number of publications,** the general projection approach employed here relies on the assumption that the relationships identified by the regression analysis remain constant in the future (throughout the projection period). This is obviously an heroic assumption. Again, if several consistent cross-sectional surveys were available, some evaluation of this assumption (either qualitative or quantitative) might be possible by repeating the regression analysis on each survey's data set, and observing the trend in equation parameters. In the absence of

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*See Kirschner Associates (1975) for an excellent discussion concerning the consistency (or lack thereof) in previous National recreation survey efforts.

**McGurk (1975), Jungst (1978), Cicchetti, Seneca, and Davidson (1969), Kalter and Gosse (1969), Adams, Lewis, and Drake (1973).

such consistent surveys, little analysis can be performed. A time-diary approach, if employed over a rather long period of time, might also support some time-series evaluation of relationship constancy.

Necessity of Independent Variable Projection

In the development of the participation projections, it is necessary to project the independent variables in the participation equations. It is necessary, in some cases, to rely on historical trends to estimate these projections. It should be pointed out that, in such a circumstance, this approach is equivalent to a simple time-trend projection of participation. For example, if:

$$\bar{y} = A + B\,\bar{x}$$

is the participation equation which will be used to project $\bar{y}$, and if $\bar{x}$ is projected by:

$$\bar{x} = C + D\,t \qquad (t = \text{time}),$$

then:

$$\bar{y} = (A + BC) + (BD)t.$$

Thus, this projection procedure is equivalent to simply regressing participation against time. This approach is still somewhat superior to a simple time-trend analysis, because it at least estimates the relationships between participation and its determinants, and it may give some indications concerning the components of the change over time. Nonetheless, the participation projections will be no better than the independent variable projections developed, and this task may, in some cases, be just as difficult as the original task of projecting participation. For the sake of

consistency, it seems that the independent variable projections should be included, as is possible, in the Basic Assumptions section of the RPA Assessment. Thus, they will not be discussed further, except to note that the quality of all forest product consumption projections would be improved if the Basic Assumptions were expanded to include more socio-economic variables.

Multicollinearity

Some degree of multicollinearity can be expected in almost any data set to be used in the regression analysis. Kmenta (1971) discusses the disturbances caused by "a high degree of multicollinearity," and concludes that:

> . . . it is important to realize that a high degree of multicollinearity is simply a feature of the sample that contributes to unrealiability of the estimated coefficients, but has no relevance for the conclusions drawn as a result of this unreliability. If the estimated regression coefficients are highly unreliable--that is, if they have large variances--the acceptance region for the hypothesis that a given regression coefficient is zero will be wide. In turn, this means that the power of the test is weak. (p. 391)

Thus, it must be pointed out that, though the presence of multicollinearity in the data set will not directly bias the regression coefficients or invalidate the goodness-of-fit tests, it will tend to create large variances in the estimators, and thus lead to more unreliable coefficients.

Use of the step-wise procedure should eliminate much of this problem since no variable will be included in the final equations derived in such a procedure unless it contributes a statistically significant, unique explanation of the variance of the dependent variable. And, for purely predictive purposes, multicollinearity may not cause too serious a problem because, as Kalter and Gosse (1969) state:

> . . . intercorrelations among the explanatory variables, if present, can affect the estimates of all the parameters of the relationship, since regression analysis cannot completely separate the individual effects of several intercorrelated explanatory variables. However, the technique does yield estimates of the net relation between the dependent variable and each of a set of intercorrelated variables. If, in the future, the multicollinearity is expected to continue at about the same level, then the intercorrelations may not distort the results significantly. (pp. 9-10)

Nonetheless, in any future analysis of this type, it is strongly suggested that a correlation matrix be studied. If significant multicollinearity is indicated, then the feasibility of using Ridge Regression might be evaluated to increase the regression's reliability. It is anticipated, however, that the computation and interpretation complications of this approach would make it less than worthwhile.

Underspecification

The R-squares for regression equations in this type of analysis tend to be quite low. This would indicate that, in terms of explaining individual behavior, the regression equations are underspecified. It is possible that much of this unexplained variation in individual behavior will be essentially constant in the future, and thus the projections of aggregate behavior are valid. Nonetheless, this problem taken together with the assumed constancy of relationships indicates a potential for substantial variation in future recreation participation which is not explained by the participation equations. Furthermore, it is possible that this underspecification will bias the parameters in the participation equation on the variables that are specified (see Hof, 1979). As Kmenta (1971) states:

> . . . if the omitted explanatory variable is correlated with the included explanatory variable, the estimators of B_1 and B_2 will be biased and inconsistent. If the omitted explanatory variable is <u>not</u> correlated with the included variable, the estimator of B_1 will still be biased and inconsistent, at least in general, but the estimator for B_2 will be unbiased. However, the estimator of the <u>variance</u> of $\hat{B}_2$ will contain an upward bias so that the usual tests of significance and confidence intervals for B_2 will tend to lead to unduly conservative conclusions. (p. 394)

> (Note: here, B_1 refers to the intercept term, B_2 the coefficient of the variable that was included.)

This would then indicate that the absence of correlation between included and omitted variables is desirable. This may actually not be the case in terms of the reliability of the final participation projections, because the part of the variance of the omitted variable which is correlated with the included variable <u>is</u> the cause of the bias in $\hat{B}_2$. Thus, part of the omitted variable may then be accounted for by the bias. Interpretations concerning the relationship between the included variable and the dependent variable would clearly be distorted, however. And, if the correlation between included variables and omitted variables changes over time, then the projection would <u>not</u> accurately reflect the effect of the omitted variable.

This is probably the most nagging problem in participation projection--we really do not know the determinants of recreation behavior. Again, social-psychological work such as that of Driver and Brown (1975) probably shows the greatest promise in improving our understanding of these determinants. Recent work by King (1980) should also suggest specification improvements.

Identification

The problem of identification in regressing participation equations such as those in this analysis has been discussed by a number of authors, most notably, Kalter and Gosse (1969, 1970) and Cichetti (1973). Both of these authors take the position that public recreation behaves within a "market" structure (in aggregate terms), where price does not appear in the supply function. Kalter and Gosse (1969) state that:

> . . . the supply function is somewhat insulated from market forces by the institutional setting from which it is forthcoming. (p. 10)

And, Cicchetti (1973) draws a vertical supply curve in the "Aggregate Market for Outdoor Recreation," saying that: "At any given point in time the facilities available to the population are given." (p. 24)

If this structure is accepted, then no simultaneous system exists between price and quantity. Price does not appear in the supply relationship and no rigid equilibrium condition between quantity demanded and quantity supplied exists. Thus, no identification problem exists, <u>per se</u>. The main issues which Kalter and Gosse, and Cichetti discuss, then, would be specification questions -- the proper way to account for variation in supply in their statistical models, which appear to analyze consumption, rather than demand.*

In terms of consumption (as opposed to quantity demanded), however, a simultaneous system might be operating since consumption is affected by availability of recreation resources, and the public sector is indicated to be sensitive to levels of use (consumption). Thus, define:

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*Kalter and Gosse (1970) define "consumption" as the equilibrium level of quantity demanded and supplied. They do not discuss the possibility that this equilibrium may not occur empirically.

$$Q_c = f(P, x_i, Q_p, \mu_c) \tag{1}$$

$$Q_p = g(Y_j, Q_c, \mu_p) \tag{2}$$

Where:

Q_c = the quantity of recreation resources actually consumed

Q_p = the quantity of recreation resources provided by the public sector

x_i = the traditional demand shifters

Y_j = the political, financial, or precedent variables affecting public sector decisions

P = price surrogate

μ_c, μ_p = residuals.

This model is a simultaneous system, and thus may suffer an identification problem. It should be emphasized that this is not a market equilibrium system between supply and demand, but rather, an equilibrium system describing the interaction between consumption and public provision of recreation opportunities.

The reduced form equations for this system of equations are given below:

$$Q_c = f' \ (P, x_i, Y_j, \mu_c) \tag{3}$$

$$Q_p = g' \ (P, x_i, Y_j, \mu_p) \tag{4}$$

Thus, if Q_c is regressed against not only the arguments in (1), but also the supply shifters, Y_j, then Q_c can be consistently projected with (3). Without inclusion of the Y_j, however, the only cases in which Q_c can be consistently projected is where (1) is absolutely fixed, or where no simultaneity actually exists (either e or b equals zero). If neither of these conditions is tenable, the usual approach is to regress the reduced forms (3) and (4), and then derive the structural model from them.*

However, a serious problem remains -- since equation (2) describes the behavior of a public body, identifying and measuring the Y_j may be extremely difficult. These shifters might include such factors as political whimsy, previously determined public policy, vote trading behavior in the political system, and other factors which would be pragmatically impossible to include in a regression model. Thus, in order to regress a participation equation, we are left with only two choices:

1) Regress $Q_c = f(P, x_i, Q_p, \mu_c)$
   and risk a simultaneity bias, or
2) Regress $Q_c = f(P, x_i, \mu_c)$
   and risk an underspecification bias (having left out the Y_j).

The former course is suggested for three reasons:

1) The underspecification of these models is already so severe that further underspecification is thoroughly unacceptable.
2) If, in the data set used, the supply of recreation resources is predominantly an independent variable (either in the private market, or by a public sector which is acting independently or

*For further discussion on this reduced form (two-stage) approach, see Kmenta (1971) or Johnston (1972).

with a time lag), then no simultaneity bias will be present, and

3) Q_p, or part of it, is the choice variable for the Forest Service in its allocation problem -- the quantity of recreation resources to be produced. Thus, inclusion of this variable in the participation equations would seem to be very important as long as it significantly affects Q_c. If a simultaneity bias exists as a result of a data problem which makes impossible the specification of the entire equilibrium system, then this may lead to erroneous conclusions. However, these conclusions could hardly be more erroneous in application than presenting participation equations which are unaffected by the opportunity to participate.

Aggregation Bias

Another potentially serious problem in the methodology employed is an aggregation bias in the participation equations. This problem arises because the data from a cross-sectional survey describe individual behavior, whereas the identified relationships are used to project aggregated use levels subject to projections of aggregated explanatory variables.

For simplicity, consider only the relationship between recreation participation (P) and say, income (I). And, assume we have a set of micro-relationships:

$$P_j = a_j \cdot I_j + k_j \qquad j = 1, n \text{ individuals}$$

The correct aggregation of these micro-relationships to yield an average participation rate would be:

$$\frac{\sum_{j=1}^{n} P_j}{n} = \frac{\sum_{j=1}^{n} (a_j \cdot I_j)}{n} + \frac{\sum_{j=1}^{n} k_j}{n} \quad . \tag{5}$$

However, if regression analysis is performed on cross-sectional data, and this equation is combined with a projection of average income, then the projected average participation rate would be:

$$\frac{\sum_{j=1}^{n} P_j}{n} = \frac{\sum_{j=1}^{n} a_j}{n} \cdot \frac{\sum_{j=1}^{n} I_j}{n} + \frac{\sum_{j=1}^{n} k_j}{n} \tag{6}$$

which is equivalent to (5) only if all a_j are equal (to $\bar{a}_j$). Otherwise, an aggregation bias will exist in the projections of the average participation rate.

In other words, if regression analysis is performed on cross sectional survey data to estimate the relationships between participation and some given explanatory variables, these relationships can only be used to project aggregate use with an assumption of homogeneous population behavior characteristics.

This bias in projected participation could theoretically be removed if average per capita income ($\bar{I}_j$) is a weighted average (weighted by $\frac{a_j}{\bar{a}_j}$). Thus:

$$\bar{I} = \frac{\sum_{j=1}^{n} \frac{a_j}{\bar{a}_j} \cdot I_j}{n} \qquad \text{would yield:}$$

$$\frac{\sum_{j=1}^{n} P_j}{n} = \frac{\sum_{j=1}^{n} a_j}{n} \cdot \frac{\frac{n}{n} \cdot \frac{\sum_{j=1}^{n} a_j I_j}{\sum_{j=1}^{n} a_j}}{n} + \frac{\sum_{j=1}^{n} k_j}{n} \quad \text{instead of (6),}$$

which is:

$$\frac{\sum_{j=1}^{n} P_j}{n} = \frac{\sum_{j=1}^{n} a_j I_j}{n} + \frac{\sum_{j=1}^{n} k_j}{n} .$$

which is exactly the same as (5). This is explained more fully in Hof (1979).

Therefore, if the micro-parameters (a_j) could be identified for various levels of income, and if the income structure (distribution) could be projected as well as total (or per capita) income, then a weighted average income could perhaps be used with the macro-parameters ($\bar{a}_j$ and $\bar{k}_j$) to project $\bar{P}$ without an aggregation bias. Considering the number of independent variables in the participation equations, however, such procedures do not appear to be feasible. This weighting structure does clearly indicate, however, that the magnitude of this bias is determined by the degree to which the micro-parameters (a_j's) vary across different individuals.

The only way to directly avoid this problem would be to study aggregated behavior instead of individual behavior in the regression analysis. In terms of investigating the causal factors of recreation participation, this approach would be disadvantageous because the aggregation of behavioral indicators might obscure many of the relationships to be investigated. If combined cross-sectional and time-series data are made available, some estimate could

be made of the variability in micro-parameters between individuals which causes the aggregation bias in the first place. Finally, the better the participation equations are specified, the more likely homogenous micro-parameters are. Thus, improved specification will certainly ameliorate this problem of aggregation.

Heteroskedasticity

Goldberger (1964) demonstrated that ordinary least-squares (OLS) estimation with a dichotomous dependent variable will have heteroskedastic residuals -- the variance of the residuals will vary systematically with the independent variables. This condition makes the OLS estimation procedure inefficient. It should be noted at this point that these inefficient estimators will be unbiased in large sample sizes, since they do have the proper asymptotic properties (Goldberger, 1964; Kmenta, 1971; Johnston, 1972). It is this property which is probably responsible for the common use of OLS in this type of analysis, despite the inefficiency. For example, Cichetti, Seneca and Davidson (1969) state:

> Considering classical least squares versus generalized least squares or probit analysis, theoretical problems, practical considerations, computational efficiency, computational costs, and the state of the art, which favors improved specifications over computational sophistication, the technique used for this study was classical least squares. (p. 80)

And, Deyak and Smith (1978) state:

> Sampling experiments have suggested that the bias in the OLS variance-covariance matrix for the estimated coefficients in the presence of the heterskedasticity implied by Goldberger's error structure is not great. Moreover, case study evaluations of a variety of techniques by Gunderson and Watson have found OLS performs well with large samples and the potential predictive

distortions from the use of OLS versus nonlinear alternatives (i.e., logit and probit) are not sufficient to favor one technique over the others. This conclusion is further supported by the evidence on the technique's performance in hypothesis testing. Thus, since OLS seem quite robust and offers ready interpretations for the estimated coefficients, we have utilized it in our analysis. (p. 73)

Adams, Lewis and Drake (1973) did not, however, feel that the goodness-of-fit tests were reliable, saying:

The parameters of the participation equations were calculated using the classical least squares procedure. This method introduces a bias into the estimates of the variance of the estimates of the parameters. The effect of this bias was not known and therefore these variances were not used for hypothesis testing purposes. As a result no measures of the statistical reliability of the estimated participation functions are presented. (p. 103)

If the analysis is based on a large survey sample size, it can probably be assumed that the parameters estimated are not significantly biased by heteroskedasticity. Some question does seem to remain, however, concerning the reliability of the tests for statistical significance (the F test, specifically). It can be heuristically demonstrated (Hof, 1979) that this bias on the test statistics will be most conservative if the mean of the dependent variable is 1/2, and that the bias will be predominantly conservative if the mean of the dependent variable is between 1/4 and 3/4. This is intuitively appealing, because the degree of concentration of either 0 or 1 responses in the dependent variable would be minimized when the participation rate is 50 percent.

It is thus recommended that the more exotic alternatives* to OLS be employed whenever small sample sizes are encountered. And, it is suggested that OLS will not be totally unacceptable with the large sample sizes that make these exotic methods impractical.

All of this presupposes, of course, that the zero-one dependent variable structure is used. A heteroskedasticity problem is hard to avoid, however, because in a National sample, we can generally expect a large cluster of zero responses. That is, even if we simply regress, say, number of trips, the large number of respondents who did not take any will tend to create heteroskedastic residuals anyway.

Conclusions Concerning Participation Projection

Aside from a few methodological suggestions made above, the basic approach that is recommended is that employed for the 1980 Assessment. The data base from which the participation equations in this approach are estimated can be improved substantially, however. Thus, before proceding to the topic of benefit estimation, the recommendations for obtaining this data base should be summarized.

1.) In general, the data set should be collected expressly for this purpose if at all possible. Many of the difficulties outlined above arise because the data sets previously used for participation equation estimation were actually collected for other purposes.

2.) Before beginning this data collection effort, the recreation commodities must be carefully defined. Work by Driver and Brown (1975) should

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*These include Generalized Least Squares and Logit or Probit analysis (Goldberger, 1964; Cicchetti, Seneca, and Davidson, 1969).

prove very helpful in this regard. It seems reasonable that recreation commodities should be delineated according to the type of overt activity involved; however, this may not be sufficient. Inclusion of the psychological outcomes of recreation activity should improve its specification. In terms of Forest Service planning, it may be desireable to reduce the number of activities analyzed to facilitate the inclusion of Driver and Brown's definitional information.

3.) The data collection effort should not only determine what activities a respondent participates in, but should also attempt to measure intensity of that participation. At least the number of "trips" or "visits" should be determined. It would also be very useful to obtain an estimate of the duration of those trips. If nothing else, this could provide an estimate of both the average length of a given type of "trip" and the variability in that length between individuals. Again, it seems that it would be better to reduce the number of activities (or recreation commodities) analyzed in order to analyze some of them in more detail and with better precision.

4.) Critical in the design of the data collection effort is the set of participation determinants to be included. Work by King (1968, 1976, 1980), Driver and Brown (1975), and the other classic literature on forecasting recreation should provide a good start. It may prove worthwhile, however, to perform a pre-survey survey in order to improve our understanding of participation determinants. At this point in time, it can be recommended that in addition to those determinants included in existing data sets, at least price (possibly travel

cost) and supply availability information should be included.

5.) It is more important to obtain a good random sample than it is to obtain huge numbers of observations. Similarly, it is better to collect less information precisely than more information imprecisely. Thus, it is recommended that size of the survey be minimized both in terms of questionnaire length and sample size so as to maximize the reliability of the information that is obtained.

6.) Combined cross-sectional and time-series data would be very useful for a variety of reasons mentioned above. Thus, if feasible, it is recommended that either a time-diary survey be implemented or that a single response survey be repeated over time. The more time covered by the observations, the better, so in this respect the repeated survey may be more practical. Also, the time-diary approach would have to involve more respondent time and may require incentives to avoid low response rates. The time-diary approach, however, would allow sequential observations on a single individual, which could prove valuable both in estimating relationships and in testing for reliability in those relationships. If a single response survey is to be employed (and hopefully repeated) then a random-dial telephone survey would probably prove most workable.

7.) Finally, wherever it is at all possible, quantitative responses should be obtained from the survey respondents. Qualitative categories should be avoided because they are not conducive to the quantitative analysis involved in estimating participation equations. This includes such

things as asking the respondent for an age bracket or income bracket. Response rates may suffer, but qualitative responses are simply not as useful as quantitative ones.

THE METHODOLOGY OF OUTDOOR RECREATION BENEFIT ESTIMATION

It has been well documented that two basic approaches for estimating recreation benefits are theoretically valid: the "travel cost approach" and the "interview" or "bidding game" approach (Hof, 1979; Knetsch and Davis, 1972; O'Connell, 1977; Dwyer, Kelley and Bowes, 1977). The former has the advantage of being based on actual, observed behavior rather than hypothetical interview responses. Thus, it is generally and tentatively recommended that the travel cost approach be employed whenever feasible. The traditional travel cost approach is discussed in some detail and an extension of the "state-of-the-art" is suggested. Finally, the bidding game approach is discussed with some general indications given of how to minimize biases created by its hypothetical nature.

The Traditional Travel Cost Model

The early presentations (HCK)* of the travel cost model employed a conceptual specification of recreation commodities in something of a Household Production Function framework where:

$E = f(R, T, X)$

E = Recreation Experiences

R = Recreation Resources

T = Travel

X = Other factors of production not considered

f = A Household Production Function

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*Hotelling (1949), Clawson (1959), Clawson and Knetsch (1966).

That is, the consumer was assumed to be producing recreation experiences from a variety of production factors -- especially travel and the recreation resource. Since the resource is generally priced at or near zero, the cost of travel was logically indicated to be the cost of the experience (so long as no other costs of producing experiences were important). Thus, observing individuals' recreation trip-taking behavior who face different travel costs is taken as a reasonable approach in deriving a demand curve for recreation experiences, given the assumptions discussed in the classic literature.

The HCK approach did not stop here, however. This demand curve for the experience will be referred to as the "first stage" model. HCK also present a "second stage" model which they discuss as a derived demand curve for the recreation resource -- "derived" apparently in the sense that it is a demand curve for a factor of production that is derived from the demand curve for the final product.

Though recent literature seems to generally avoid labelling the second stage model as a "derived demand curve" it is still often presented as a demand curve for the "site", or "recreation resource".*

The basic assumption which purportedly allows the interpretation of the second stage model as a demand curve for the recreation resource is:

> . . .the average of one large group of recreation users will react to costs in the same way as the average of another large group of users. (Clawson and Knetsch, 1966, p. 78)

This has also been stated as:

> the corresponding changes in visit quantities are calculated as if the increase in park price is viewed no differently by the consumers than an increase in travel cost. (Cesario and Knetsch, 1976, p. 99)

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*See, for example, Cesario and Knetsch (1976), and Dwyer, Kelley, and Bowes (1977).

The "reaction" which the second stage model observes is actually a change not only in the consumption of the resource, but also a change in the consumption of travel. In other words, all that has been measured is a change in the consumption of experiences -- including both travel and resource input utilization. A change in resource consumption associated with a resource price change has never been isolated. Likewise, the aglomeration of travel costs and resource costs into "costs" indicates that the analysis has never proceeded beyond observing experience consumption. All of this is evidenced by the fact that the second stage model is in the same units as the first stage model -- number of visits and price of a visit (or more precisely, a given change in the price of a visit).

Furthermore, in the Household Production Function framework the value of the recreation resource is generated by its capability to produce the utility-providing final good, the recreation experience. Economic theory indicates this conclusion by stating that the efficient, equilibrium price of any factor is its value-marginal-product -- the marginal physical product of a factor X in producing good Y times the equilibrium price of that good Y (Henderson and Quandt, 1971). In other words, the correct value index for the recreation resource is derived by multiplying the experience value index by the marginal product of the resource in producing that experience. The second stage HCK model does not seem to be consistent with this conclusion.

Some questions must be raised as to whether this marginal product exists for the recreation experience Household Production Function. It appears that for some level of consumption of recreation experiences, a

certain mix of inputs (especially travel and recreation resources) is absolutely necessary, and that no trade-off between these factors is possible. This would indicate that no true isoquant exists (it is a single point) and therefore the marginal product is undefined at the relevant point of analysis. If this is the case, then traditional economic theory does not indicate the "correct" factor price, and consumption of the resource will be determined by the consumption of experiences -- again the consumption of the resource would not be isolable from that of the experience. Interestingly, this logic indicates that even if a public recreation site was "priced" with an entry fee, the correct value index would have to include the necessary transfer cost (travel cost), and the resource may still be inseparable from the experience.

Even if an isoquant and marginal products do exist for the production of experiences, the travel cost model is still incapable of deriving a demand curve for the resource, *per se*. Assume that the recreation resource to be evaluated has no directly attached price (such are the conditions which necessitate an evaluation analysis). Also, assume that P_E is an acceptable equilibrium price of the experience, at the equilibrium level of consumption E. The rational consumer/producer will then minimize the cost of production of E.

Assume two factors of production:

R = recreation resource

T = travel

and a consumer production function:

$$E = f(R, T).$$

And, minimize:

$$C = P_R \cdot R + P_T \cdot T$$

Subject to:

$$E \leq f(R, T)$$

Where:

C = cost of production of experiences

P_R, P_T = prices of the recreation resource and travel, respectively

E = number of experiences.

Forming the Lagrangean:

$$L = P_R \cdot R + P_T \cdot T + \lambda \cdot [E - f(R, T)]$$

And, deriving first-order conditions:

$$\frac{\partial L}{\partial R} = P_R - \lambda\frac{\partial f}{\partial R} \overset{\text{set}}{=} 0$$

$$\frac{\partial L}{\partial T} = P_T - \lambda\frac{\partial f}{\partial T} \overset{\text{set}}{=} 0$$

$\frac{\partial L}{\partial \lambda} \overset{\text{set}}{=} 0$, the constraint is binding.

and, $\frac{\partial L}{\partial E} = \lambda$, marginal cost of E.

Thus, one first order condition is:

$$P_R = \lambda\frac{\partial f}{\partial R} = \left[\begin{array}{c}\text{the marginal cost of the}\\ \text{marginal experience}\end{array}\right] \cdot \left[\begin{array}{c}\text{marginal product of}\\ \text{the resource}\end{array}\right].$$

(This is analagous to value-marginal-product pricing in the theory of the firm.)

But:

$P_R = 0$ (the resource is "free").*

Therefore, the consumer will utilize R until its marginal product is 0.

This indicates that if the recreation resource is zero-priced and an isoquant exists between travel and the resource, then the consumer would operate accordingly at the resource-axis intercept of that isoquant. This will be true <u>regardless of the cost of the other factor, travel</u>, so long as it is non-zero. Therefore, in this case, the cost of travel has nothing to do with the consumption of the resource except that the equilibrium quantity of <u>experiences</u> demanded (E) is affected by travel costs. Just as before, travel costs can only be related to the consumption of experiences, not to the consumption of the resource. The first point calculated in the HCK second stage model is the horizontal intercept of the "derived demand curve", corresponding to the resource axis intercept of the isoquant. At no time, however, have we been able to observe the consumer when his marginal product of the resource in producing the experience was anything but 0.

It is concluded, therefore, that travel costs cannot be employed to identify a derived demand curve for the recreation resource, <u>per se</u>. The

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*It is possible that the consumption of R will be restricted by limited resource capacity. In this case, the condition that $P_R = \lambda \cdot \frac{\partial f}{\partial R}$ does not hold. That is, consumption of R is determined not by efficiency criteria, but rather, an exogenous constraint. Thus, the $\frac{\partial f}{\partial R}$ at that point would not be the correct one, and the derived P_R would reflect the limited quantity of R, and not the value of R in producing E.

cost of travel is the (transaction cost) price of the experience commodity and changes in the quantity of travel and resource inputs utilized cannot be isolated.*

Public Provision of Recreation

In contrast to the Household Production Function discussed above, a public agency can be regarded as an "experience producer" which can trade-off travel for resource inputs to production, and faces a non-zero resource price. The more recreation sites that are available to a "community", the less "community" travel is necessary for a given number of recreation experiences to be "produced". Thus, implicitly, a public land agency is allocating community travel and recreation resources given the aggregate demand curve for the recreation experience based on individual willingnesses-to-pay.

If, in a given instance, the travel input to a community's recreation could be considered "correct" (efficient), then the value marginal-product of a proposed recreation site might be regarded as the value of additional community recreation experiences which the site could provide, given that fixed amount of travel.

Pragmatically, the "present" amount of recreation travel could rarely be regarded as being "correct", and thus a new site may create both an increase in the number of experiences and a cost savings by allowing a different mix of travel and resource inputs. This then suggests the

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*Mäler (1974) and Freeman (1979) both present interesting discussions concerning shifts in demand for private commodities resulting from qualitative environmental improvements. If a proposed site is perceived as a qualitative improvement resulting in a shift in the demand curve for the experience (given a fixed travel input) then a site's value may be isolable. It seems more reasonable, however, that the construction of a new site causes a price (travel cost) reduction and a shift along a fixed experience demand curve.

basic approach taken by Burt and Brewer (1971), and later applied by Cichetti, Fisher, and Smith (1976). They develop a benefit measure from the experience "price" changes which occur with the construction of a proposed site (or the removal of an existing site). That is,

> "Development of the site will change the minimum distance (price) that some of the population must travel (pay) in order to consume services from the category of sites in which the development fits. Thus, an investment in outdoor recreation will change the price vector faced by at least some of the population." (Burt and Brewer, p. 815).

Thus, the value of an additional site is the change in total net value of experiences it creates. This total net value change includes: an increase in gross willingness to pay; a travel cost change; and the additional variable costs of operating the new recreation site and amortized cost of the investment itself.*

The change in gross willingness to pay less travel costs is equivalent to the change in consumers surplus caused by the price shift (the area to the left of the experience demand curve, between the two price horizontals). This welfare measure involves changes along the demand curve for the experience, and the demand for the resource is never considered in the analysis, _per se_. In fact, this "experience" is defined as a fixed composite of travel time and the site experience. As Burt and Brewer state:

> "...travel time and the recreation experience itself are a package of commodities in the usual economic sense, and the consumer has no alternative to the particular package presented to him by his spatial location. The situation is analagous to a consumer

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*It is theoretically undesirable to intermingle production cost efficiency and benefit estimation in this manner; however, in an applied context, there seems to be little alternative at this time.

> being refused a price quotation on a commodity that he wishes to purchase, but instead, he is quoted a price per unit of that commodity taken with so many units of another commodity... As long as purchases have to be made in this fixed proportion, all value inferences can be made from the aggregate commodity." (Burt and Brewer, 1971, p. 826).

Thus, the value of the proposed site is not determined by its own demand curve, but rather by the price-change-induced increase in welfare created by the consumption of the composite commodity. Burt and Brewer demonstrate that this indicator is actually equivalent to the entire area under the HCK second stage curve in the case of only one site.* They demonstrate that the area under the HCK second stage curve is actually a horizontal summation of first stage experience demand consumers surpluses of each individual, with the travel cost for each acting as the surrogate price line above which the surplus is calculated. Therefore, the benefit estimates derived from the HCK second stage demand curve are not erroneous, they have merely been misinterpreted. This is important because as long as the second stage model is misinterpreted as a demand curve, then inappropriate commodity definitions are likely to be employed. That is, if we presume that our demand analysis is based on the site, then site characteristics will define the commodity set. If, however, site use cannot be meaningfully isolated from the composite experience commodity, then experience characteristics should be used to define the commodity set. A demand curve will thus apply to a particular type of experience rather than a type of resource. Furthermore, in an aggregate demand curve, the experience "type" must be constant over all consumers rather than resource "type".

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*This implies a price change from infinity to the travel cost (price) of the one site. If the HCK approach is used when this is not the case, a significant over-estimate of benefits is possible.

An Extension of the Burt and Brewer Approach

It would appear from the preceding argument that an improved means of defining recreation experience commodities would be highly desirable in the type of approach taken by Burt and Brewer. An additional advantage is that in evaluating a proposed (non-existent) site, the demand for experiences at another site must be used. This other site should ideally be a perfect substitute for the proposed site. If the experiences occurring at various sites are defined according to their own characteristics, then selection of a "best-substitute" site would be facilitated. As Cicchetti, Fisher and Smith state:

> "Since we do not know the demand for Mineral King in advance, we approximate it with the demand for the composite June Mountain -- Mammoth Mountain facility. ...we are assuming that Mineral King and June-Mammoth sites provide services which are perfect substitutes. To the extent this assumption is invalid the estimate of benefits from the development of the Mineral King will be biased." (Cicchetti, Fisher, and Smith, 1976, pp. 1271-72).

On the basis of these factors, it would appear to be highly worthwhile to specify the commodities according to characteristics of the experience commodity. Work in the area of social/psychological determinants of recreation behavior (Driver and Brown, 1975) provides the means by which this might be accomplished. This work identifies a set of "psychological outcomes" of recreation activity and measures the relative values that different individuals place on these outcomes. If separate demand curves are identified for those individuals that have similar valuations of the psychological outcomes from some recreation activity, then we will have a vector of commodities which better reflect the consumption process. That is,

individuals with similar valuations for the psychological outcomes of using a given site are indicated to be consuming more or less the same experience commodity. The welfare indicator derived from the first stage demand curve will thus relate to a better-specified commodity, and will involve less heroic assumptions concerning homogeniety among individual demand curves in the analysis. The use of the psychological outcomes in this fashion is discussed in more detail by King (1980). A simplifciation of the Burt and Brewer approach will next be discussed.

A Simplification of the Burt and Brewer Approach

Since Burt and Brewer wished to evaluate a new site introduced into a situation with substitutes for that site already present, their approach was to:

1.) Derive a system of demand functions for the set of alternative recreation opportunities, sites or groups of sites (types).

2.) Determine that recreation site which is the closest substitute for the proposed site.

3.) Determine the effective price change(s) which the new site will create for this closest substitute.

4.) Utilize the line integral of this system of demand functions between before and after price vectors.

In order to avoid theoretical problems with the use of a consumer surplus welfare measure, symmetrical cross-price terms were assumed. Briefly, this is necessary in order to make the value of the line integral independent

of the path of integration. Since the quantities demanded can adjust in any number of ways to the new "equilibrium", no unique path of integration exists for the system of demand curves. In this instance, where: demand curves are linear; cross-price terms are symmetrical; and only one price in the price vector changes; the line integral of the system of demand functions is actually equivalent to the simple integral of the (closest substitute) demand curve over its own price change. This will be demonstrated below.

Start with a system of m demand functions:

$$\underset{(m\times 1)}{\tilde{Q}} = \underset{(m\times 1)}{\tilde{a}} + \underset{(m\times m)}{\tilde{B}}\ \underset{(m\times 1)}{\tilde{P}}$$

(All non-scalars are marked "$\sim$")

Now, assume <u>one</u> price changes in vector $\tilde{P}$, say (for notational convenience), P_1. Assume that P_1 <u>decreases</u> from P_1^0 to P_1^*, which creates two $\tilde{P}$ vectors, $\tilde{P}^0$ and $\tilde{P}$

The Burt and Brewer welfare indicator for this price change would be:

$$1/2\ \tilde{P}^{0\prime}\tilde{B}\ \tilde{P}^0 + \tilde{a}'\tilde{P}^0 - [1/2\tilde{P}^{*\prime}\ \tilde{B}\ \tilde{P}^* + \tilde{a}'\tilde{P}^*]$$

Note: $P^{0\prime}$ indicates the transpose of P^0, etc.

Now, write $\tilde{Q} = \tilde{a} + \tilde{B}\ \tilde{P}$

as:
$$\begin{bmatrix} q_1 \\ \cdot \\ \cdot \\ \cdot \\ q_m \end{bmatrix} = \begin{bmatrix} a_1 \\ \cdot \\ \cdot \\ \cdot \\ a_m \end{bmatrix} + \begin{bmatrix} b_{11} & \cdots & b_{1m} \\ \cdot & & \cdot \\ \cdot & & \cdot \\ \cdot & & \cdot \\ b_{m1} & \cdots & b_{mm} \end{bmatrix} \cdot \begin{bmatrix} P_1 \\ \cdot \\ \cdot \\ \cdot \\ P_m \end{bmatrix}$$

so, for the first site (commodity):

$$q_1 = a_1 + b_{11} p_1 + b_{12} p_2 + \ldots + b_{1m}\ pm$$

or: $$q_1 = a_1 + \sum_{j=1}^{m} b_{1j}\ p_j$$

and: $$\int_{p_1^*}^{p_1^\circ} q_1\ dp_1 = 1/2\ b_{11} (p_1^\circ)^2 + p_1^\circ (a_1 + \sum_{j=2}^{m} b_{1j}\ p_j)$$

$$- [\ 1/2\ b_{11} (p_1^*)^2 + p_1^*\ (a_1 + \sum_{j=2}^{m} b_{1j}\ p_j] \qquad (7)$$

I will show that this is equivalent to the Burt and Brewer line (or vector) integral welfare indicator.

$$1/2\ \underset{\sim}{P}'\underset{\sim}{B}\ \underset{\sim}{P} + \underset{\sim}{a}'\ \underset{\sim}{P} =$$

$$\sum_{i=1}^{m} a_i p_i + 1/2 \sum_{i=1}^{m} p_i \sum_{j=1}^{m} b_{ij}\ p_j \qquad \text{for any } \underset{\sim}{P},$$

so, Burt and Brewer's welfare indicator for a change from p_1° to p_1^* would be:

$$a_1 p_1^\circ + \sum_{i=2}^{m} a_i p_i + 1/2\ b_{11} (p_1^\circ)^2 + 1/2\ p_1^\circ \sum_{j=2}^{m} b_{1j} p_j + 1/2\ p_1^\circ \sum_{i=2}^{m} b_{i1}\ p_i +$$

$$1/2 \sum_{i=2}^{m} p_i \sum_{j=2}^{m} b_{ij} p_j$$

$$- [a_1 p_1^* + \sum_{i=2}^{m} a_i p_i + 1/2\ b_{11} (p_1^*)^2 + 1/2\ p_1^* \sum_{j=2}^{m} b_{1j} p_j + 1/2\ p_1^* \sum_{i=2}^{m} b_{i1} p_i +$$

$$1/2 \sum_{i=2}^{m} p_i \sum_{j=2}^{m} b_{ij} p_j]$$

which is:

$$a_1 p_1^\circ + 1/2\ p_1^\circ \sum_{j=2}^{m} b_{1j} p_j + 1/2\ p_1^\circ \sum_{i=2}^{m} b_{i1}\ p_i + 1/2\ b_{11} (p_1^\circ)^2$$

$$- [a_1 p_1^* + 1/2\ p_1^* \sum_{j=2}^{m} b_{1j} p_j + 1/2\ p_1^* \sum_{i=2}^{m} b_{i1} p_i + 1/2\ b_{11}\ (p_1^*)^2] \tag{8}$$

Now, cross-price terms are equal, $b_{1j} = b_{j1}$, $j = 2, m$. Thus, (8) is equivalent to:

$$a_1 p_1^\circ + p_1^\circ \sum_{j=2}^{m} b_{1j} p_j + 1/2\ b_{11}\ (p_1^\circ)^2$$

$$- [a_1 p_1^* + p_1^* \sum_{j=2}^{m} b_{1j} p_j + 1/2\ b_{11}\ (p_1^*)^2]$$

which is exactly the same as (7) above. Obviously, this would hold for any single price change, not just a change in P_1.

An intuitive explanation of this result is possible if we write $\underset{\sim}{a}'\ \underset{\sim}{P} + 1/2\ \underset{\sim}{P}'\ \underset{\sim}{B}\ \underset{\sim}{P}$ as:

$$\underline{a_1 P_1} + \underline{1/2\ P_1 (B_{11} P_1 + B_{12}\ P_2 + \ldots + B_{1m} P_m)}$$

$$+ \underline{a_2 P_2} + \underline{1/2\ P_2\ (B_{21} P_1} + B_{22} P_2 + \ldots + B_{2m} P_m)$$

$$\vdots \qquad\qquad \vdots$$

$$+ \underline{a_m P_m} + \underline{1/2\ P_m (B_{m1} P_1} + B_{m2} P_2 + \ldots + B_{mm} P_m)$$

When P_1 changes, it affects the line integral only through the terms that are underlined. The prices P_2 through P_m affect the simple integral in the form:

$$P_1 \ (B_{1j} P_j), \ j = 1, m \quad .$$

This is true because P_2 through P_m are treated as constants.

In the line integral, P_2 through P_m are treated as variables and thus affect the line integral in the form:

$$1/2 \ P_1 (B_{1j} P_j) \ j = 2, m$$

and $$1/2 \ P_1 (B_{j1} P_j) \ j = 2, m \quad .$$

Now, since $B_{1j} = B_{j1}$ and since each of these forms appears once for each P_j, the total affect of each P_j is of the form:

$$P_1 \ B_{1j} P_j ,$$

just as in the simple integral. The term $1/2 \ P_1 \ (B_{11} P_1)$ is, of course, identical in both the line and simple integrals since P_1 is treated as a variable in both.

In sum, in the case of linear demand curves, a single price change, and symmetrical cross-price terms, the simple integral of the own-price demand curve with all other prices held constant will yield the same result as the line integral of the system of demand curves. It would appear that the special condition which makes the line integral path-independent (symmetrical cross-price terms) makes it unneccessary for a single price change.

It is important to note that use of the simple integral of the own demand curve still accounts for "substitution" in two ways:

1.) The own demand curve is regressed with the prices of recreation substitutes included, thus avoiding a specification error in the coefficient estimates.

2.) The benefit estimate is based not on a single, independent site, but on the price change created by the development of an additional site.

This approach does not allow for a general re-equilibration of all prices and quantities, but neither did the line integral approach. In fact, in order to equilibrate both variable prices and quantities, non-horizontal supply curves would be necessary in addition to the demand curves. (The use of fixed prices is equivalent to an assumed set of horizontal supply curves.) Beyond this simplification, the statistical approach taken by Burt and Brewer will also be simplified.

Burt and Brewer (and Cicchetti, Fischer and Smith) employed a generalized least-squares approach presented by Zellner and Lee (1965) in regressing their demand functions. This was done to allow the constraint on the set of demand curves -- symmetrical cross-price terms -- which was discussed earlier. It is suggested that ordinary least squares be employed instead of this more complicated approach. This is done for three reasons:

1) In order to employ the improved means of commodity definition discussed above as an extension to Burt and Brewer's work, a relatively large number of commodities must by analyzed. This makes the only known

algorithm for Zellner and Lee's approach infeasible (it can handle a maximum of only six commodities).

2) Recent arguments such as that of Willig (1976) indicate that the error created by using a Marshallian demand curve consumers surplus measure will be small so long as the income elasticity is not inordinately larger than unity and the total expenditure on the given commodity is a reasonably small proportion of total income. These seem to be tenable conditions for recreation demand, and Willig notes that:

> "...it is clear that in most applications the error of approximation will be very small. In fact, the error will often be overshadowed by the errors involved in estimating the demand curve."

Harberger (1971) also provides theoretical justification for the use of Marshallian consumers surplus in applied Welfare economics.

3) Empirical results such as those reported by Cicchetti, Fischer, and Smith (1976) indicate that the symmetrical restrictions on cross-price terms result in an inferior goodness-of-fit. Thus, the imposition of these artificial restrictions on the regression estimators may result in biased statistical results.*

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*We are aware that this may not necessarily be true. As Kmenta (1971) states in discussing restricted regression estimators in general: "Since the unrestricted least squares estimates minimize the sum of squares of the residuals, they lead to the maximum attainable value of R^2. This necessarily implies that the value of R^2 for the restricted sample regression equation will be lower than, or equal to, the value of R^2 for the unrestricted sample regression equation. This fact has been used sometimes as an argument for supposing that a forecast of the value of the dependent variable based on the unrestricted estimates is better than one based on the restricted estimates. If we interpret 'better' as meaning 'having a smaller (or equal) variance of the forecast error', then the argument is fallacious." (Kmenta, 1971, p. 449). If, however, the restrictions are incorrect, then their use will certainly not create a 'better' forecast.

The approach which we suggest can then be summarized into the following steps:

1) Employ the psychological outcome valuations of all respondents to subdivide them according to the type of experience they appear to be consuming. In future efforts, it may be possible to define commodities according to type of experience, without regard to location of participation. At this point, however, it seems reasonable that an experience at one site is generally going to differ from that at any other site in ways that the psychological outcome analysis cannot explain. Furthermore, separation of experience types over sites simplifies the subsequent computational procedures.

2) Determine a quantity demanded (number of trips) and a price for each site, for each respondent. The price is to be all travel costs, not just "transportation", *per se*. Thus, an approach similar to that taken by Burt and Brewer and Cichetti, Fisher, and Smith seems reasonable. This approach regresses a predictive equation for non-transportation costs from road miles, and then adds on a variable cost for auto travel. In these previous efforts, costs were attached to zones; however, if the data set is of limited size, or, if we anticipate problems with using aggregated data, each respondent could be treated as a "zone". This is similar to the "disaggregated" approach suggested by Gum and Martin (1975).

3) Regress, for each group of respondents with similar psychological outcome valuations, a set of demand functions including one equation for each recreation area. It might be necessary to assume that the respondent

consumes only one type of recreation experience from any one of the areas analyzed. That is, the number of trips to each site for a given respondent would be assumed to be measuring consumption of only one type of experience for that site. This would be necessary if, in the data set to be used, each respondent is typed according to psycholocial outcome valuations for recreating at all of the areas, rather than at each area specifically. Each demand function would include the own price, the prices of substitutes, income, and whatever other demand shifters possible.

4) Calculate a new set of individual prices for the benefit estimate needed. First, using the psychological outcome evaluations, the "best substitute" area needs to be determined. Then, to estimate the value of an existing area, the revised price vector should reflect the travel cost situation facing consumers if that site were removed. Thus, for any individual whose price of the site to be valued is less than that for the "best substitute" site, the higher price should be substituted. To estimate the benefit of a proposed site, its price vector must first be calculated. This would be calculated simply by determining the distance between each respondent and the proposed site and multiplying those distances by the cost per mile of travel determined previously. Whenever the price of the proposed site is less than the price of the "best substitute" site, it should replace the old price.

5) Finally, the benefit estimate can be calculated. As was indicated above, the simple integral (change in consumers surplus) of the "best substitute" demand curve between the old and the new price is equivalent

to the Burt and Brewer benefit indicator for a single price change.* Thus, for example, if P_1 changes from P_1^0 to P_1^* for a given individual and:

$$Q_1 = a + B_1 P_1 + \sum_{i=2}^{m} B_i P_i + CY$$

is a "representative individual" demand curve for site 1 (the "best substitute"), then:

$$[\ aP_1^0 + B_1(P_1^0)^2 + P_1^0\ (\sum_{i=2}^{m} B_i\overline{P_i} + C\overline{Y}\ )\ ]$$

$$-\ [\ aP_1^* + B_1(P_1^0)^2 + P_1\ (\sum_{i=2}^{m} B_i\overline{Pi} + C\overline{Y}\ )\ ]$$

is the new site's benefit estimate for the given individual from which operation and amortized construction cost could be deducted to arrive at net social benefits.

Note: $\bar{Y}$ refers to respondents actual income,

$\overline{P_i}$, i=2, m refers to the substitute area prices which do not change.

This section has described both elaboration and simplification of the Burt and Brewer approach, which we consider to be the "state of the art" at this time . In essence, we feel that we have eliminated some unnecessary complication and replaced it with some worthwhile complication. We invite discussion concerning these modifications and our rational for making them. We certainly do not present our approach as a panacea, but rather as a set of suggested improvements.

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* This is ignoring any possible errors created by the use of non-symmetric cross-price terms.

The Bidding Game Approach

Davis (1963) can probably be credited with the development of this method as applied to recreation. Other important efforts include: Randall, Ives and Eastman (1974); Horvath (1974); Hammock and Brown (1974); and Walsh, Ericson, McKean, and Young (1978). These works provide good basic descriptions of the approach. Dwyer, Kelly and Bowes (1977) and Brookshire and Crocker (1978) also provide excellent discussions and analysis of the methodology. Only a few additional remarks will be made here.

The principal advantage with an interview or bidding game (BG) approach is that the researcher is no longer obliged to measure phenomena that occur naturally in the real world. The BG, rather, is hypothetically constructed, and can therefore create whatever hypothetical situation desired. Thus, a BG can be designed to elicit a consumer's willingness-to-pay for the recreation resource directly. Further, the BG can be designed to attempt measurement of the complete price of the experience or resource,* since it is not limited to travel costs in its hypothetical market situation. And, finally, a bidding game can possibly identify more than one point on each individual's demand curve, and thus allow for the theoretically correct horizontal summation of these individual demand curves into the aggregate demand curve.

The questions which arise concerning the potential of bidding games, however, do so as a direct result of this same hypothetical construction.

*It is possible that travel and resource consumption would still be inseparable even in a hypothetical market situation, and that the composite, experience is still the only acceptable commodity for demand analysis.

The main question is: Will a respondent in a bidding game give responses which are equivalent to what his actions would have been had the game situation been real, rather than hypothetical?

Many authors* have discussed the potential of gaming strategies biasing the results of a BG. As Dwyer, Kelley, and Bowes (1977) summarize:

> The survey method is predicted on two key assumptions: (1) that consumers can assign an accurate value to the recreasion experience, and (2) that this valuation can be elicited from them with a properly constructed question or series of questions. The recreation survey literature has not given a great deal of attention to the first assumption. . . This second assumption has generated considerable debate. (p. 57)

Another reason that individuals who can express their valuations accurately in the market system, but may not be able to in a bidding game, is that an element of uncertainty is introduced by the artificial setting of a bidding game. The formulations below summarize the effects of strategy and uncertainty in a BG, and provide some interesting conclusions concerning the type of game most likely to provide unbiased responses.

Assume the following bidding game:

<u>Responses</u>

x_1 = consumption (# visits/year, for example) of a given site

x_2 = consumption of some other good (e.g., some timber product).

<u>Given</u>

$\bar{P}x_1$, $\bar{P}x_2$ = a set of prices given in the game for x_1 and x_2 respectively. (This is the structure most like a market framework.)

That is, each respondent will be given a set of prices ($\bar{P}x_1$ and $\bar{P}x_2$)

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*See, for example, Samuelson (1954), and Brookshire and Crocker (1978) as well as the bidding game studies previously cited.

and will be asked to give some kind of indication as to his resultant level of consumption of the associated goods (x_1 and x_2). Individual or aggregate demand curves could hypothetically be derived from these responses.

Now, assume that the following are perceived by the respondent.

Pc_1 = probability that Px_1 will actually be charged. If the respondent believes that his response affects Pc_1, then:

$Pc_1 = g_1(x_1)$

Pc_2 = a similar probability for Px_2 and x_2, and:

$Pc_2 = g_2(x_2)$

Pp_1 = probability that the given site will be provided. If the respondent believes that his response affects Pp_1, then:

$Pp_1 = f_1(x_1)$

Pp_2 = a similar probability for x_2 and Pp_2, and:

$Pp_2 = f_2(x_2)$.

Then, the rational respondent will try to maximize his expected utility, subject to his expected budget constraint.

Maximize:

$$E(U) = f_1(x_1) \cdot U(x_1) + f_2(x_2) \cdot U(x_2).$$

Subject to:

$$g_1(x_1) \cdot \bar{P}x_1 \cdot x_1 + g_2(x_2) \cdot \bar{P}x_2 \cdot x_2 \leq I.$$

This problem is analyzed in detail in Hof (1979) and it is generally concluded that the BG would generate valid relative value indexes only if:

1) $$\frac{\partial f_1}{\partial x_1} = \frac{\partial f_2}{\partial x_2} = \frac{\partial g_1}{\partial x_1} = \frac{\partial g_2}{\partial x_2} = 0$$

and,

2) $f_1(x_1) = f_2(x_2)$ and $g_1(x_1) = g_2(x_2)$.

1) would only be true if the respondent's reactions are based on his belief that his response does not affect the probabilities of either charge or provision. (Thus, no strategy exists.)

2) would only be true if:

a) no uncertainty exists, such that:

$f_1(x_1) = f_2(x_2) = g_1(x_1) = g_2(x_2) = 1$

or,

b) the uncertainty perceived by the respondent happens to be the same for all goods involved. It is important to note that in this case, the value indexes would be relatively correct, but would not be comparable with cost figures involving different uncertainty perceptions.

In order to examine the potential biases, let us assume that x_2 is a market good, such as a timber resource/product. Thus x_2 will be perceived to behave like a typical market good, and:

$f_2(x_2) = 1$

$g_1(x_1) = 1.$

Figure 1 summarizes the nine possible combinations of assumptions on f_1 and g_1, and presents the expected bias on the respondent's indication of x_1 under those different assumptions. The derivation of these biases is presented in Hof (1979).

Nature of $f_1(x_1)$ (probability of site provision) / Nature of $g_1(x_1)$ (probability of fee imposition)	$f_1 = 1$ $\frac{\partial f_1}{\partial x_1} = 0$ no uncertainty no strategy	$\frac{\partial f_1}{\partial x_1} = 0$ $0 < f_1 < 1$ uncertainty no strategy	$\frac{\partial f_1}{\partial x_1} > 0$ $0 < f_1 < 1$ uncertainty + strategy
$g_1 = 1$ $\frac{\partial g_1}{\partial x_1} = 0$ no uncertainty no strategy	(1,1) x_1 UNBIASED	(1,2) DOWNWARD BIAS on x_1	(1,3) Indeterminate
$\frac{\partial g_1}{\partial x_1} = 0$ $0 < g_1 < 1$ uncertainty no strategy	(2,1) UPWARD BIAS on x_1	(2,2) Indeterminate	(2,3) Indeterminate
$\frac{\partial g_1}{\partial x_1} > 0$ $0 < g_1 < 1$ uncertainty + strategy	(3,1) Indeterminate	(3,2) Indeterminate	(3,3) Indeterminate

Figure 1. Biases on a Bidding Game Respondent's Responses Created by Different Assumptions on His Strategy and Uncertainty.

The following conclusions can be drawn from the results of this analysis:

1) Unbiased responses will only be encountered in the absence of both strategies and uncertainty.
2) Removal of gaming strategies is not sufficient for unbiased responses. Uncertainty must also be removed.
3) Uncertainty concerning fee imposition biases the estimated demand curve upward and to the right.
4) Uncertainty about site provision biases the estimated demand curve downward and to the left.
5) A strategy to discourage fee imposition biases the estimated demand curve downward and to the left.
6) A strategy to encourage provision of a site biases the estimated demand curve upward and to the right.
7) The type of game which will be most likely to generate unbiased response is one which not only convinces the respondent that his strategies will not work, but also elicits responses which represent the respondent's expected actions given the actual existence of the site and the actual imposition of the site fee. Both gaming strategies and uncertainty might be minimized if the respondent is convinced that the "hypothetical" fee really is going to be imposed and that the site is either already available, or is definitely going to be made available in the future, at that price.

This would mean that only one price could be set for each respondent. Thus, individual demand curves could be difficult to identify. Present use with present site fees could possibly be used as a second point on the individual demand curve. Or, groups with similar characteristics could be assumed to have the same individual demand curves, allowing identification of more than one data point. Again, the hypothetical, experimental nature of the bidding game approach should provide the analyst with the opportunity to ameliorate such problems through careful experimental design.

AN OPERATIONS RESEARCH APPROACH TO MAXIMIZATION OF RECREATIONAL NET SOCIAL BENEFITS

In the earlier discussion concerning the travel cost model, it was pointed out that in considering a new site development, both a gross benefit increase and a production cost change are possible. Gross benefits increase due to the increased number of experiences expected, and production costs may change because (at the community level) the development of a new site generally involves a change in the mix of inputs. That is, the increased level of resource utilization (an additional site) is accompanied by a reduction in total community travel necessary to consume a given number of experiences. This is equivalent to a movement along the isoquant between resource inputs and travel inputs for producing experiences. It was also pointed out earlier that combining this shift along the isoquant with a shift of the isoquant (the total number of experiences consumed is increasing) is theoretically undesireable. In other words, in determining a Pareto efficient level of experiences produced, the minimum cost method of producing each experience must be known. It would seem that what is needed is a method of simultaneously determining the minimum cost and maximum net benefit solution. The purpose of this section is to describe the structure of an operations research model that could accomplish this task in a "regional planning" context.

If we begin with a geographically defined region that has a given number of population centers and a given number of proposed recreation sites (possibly of different types), than our problem is this:

> With the experience demand curves defined for the relevant experiences that the proposed sites could support, select and determine the capacity of those alternative sites which will result in the simultaneous minimization of combined site and travel costs and maximization of net benefits.

If a sufficiently wide selection of alternative sites is included in this problem, then its solution can be regarded as a Pareto optimal allocation of recreation resources (sites) and travel resources in producing a Pareto efficient number of experiences for the region involved. This region must, of course, be assumed to be a closed system with zero imports or exports. This analysis will thus be poorly suited for proposed recreation sites with wide geographical appeal. Nonetheless, it would appear that most Forest Service recreation planning problems fall within the context described.

The basic choice variables in this problem are the number of experiences (trips) to be consumed at each proposed site by individuals from each origin.* By solving optimally for these variables, we would also implicitly solve for the optimal level of development of each proposed site (possibly zero), for the optimal number of experiences provided for each origin, and for the region as a whole. The necessary cost data include the cost of each site as a function of visits** and the necessary travel cost for a visit to each site from each origin. The necessary demand data include demand curves for each origin for each type of experience that the proposed sites could support. For simplicity, it will be assumed in this discussion that each proposed site can support only one type of experience. It is suggested, of course, that these experiences be typed according to the psychological outcome evaluations developed by Driver and Brown (1975), previously discussed.

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*For the remainder of this discussion, the word "origin" will be used to indicate either "zone" or "population center" whichever is more appropriate for the specific planning situation encountered.

**This would include annual maintenance and operating cost, plus amortized development costs.

In general, the experience demand curves derived with the travel cost method as outlined above would be most conducive to this allocation model. It would be possible to aggregate all experiences for individuals from all zones into a single regional demand curve. This is considered undesireable, however, because it would incorrectly allow the marginal benefit of a zone with high marginal costs to be applied to a zone with lower marginal costs.

Since the model structure which is to be presented will utilize a linear programming solution procedure, the downward slope of each origin's demand curves will have to be approximated in a piece-wise fashion. With linear demand functions, the problem to be solved is actually a quadratic program since the simple integral of a linear demand curve is of the form:

$1/2\ B\ Q^2 + A\ Q.$

Figure 2 depicts the linear programming structure to solve this type of problem with: two types of sites, X and Y; two proposed sites of each type; two origins; and three segments of each origin's demand curve serving to approximate its downward slope. The first eight columns are the basic choice variables -- the number of trips to be taken from each origin to each proposed site. The subscript on X and Y denotes the origin. The first row contains the travel cost for each of these choice variables, and totals travel cost for the region into column 9. The second row contains the site cost for each of these choice variables and totals site costs for the region into column 10. Row 3 is an optional budget constraint on total costs. Budget constraints could also be placed on only travel costs or only site costs. The most likely budget constraint in Forest Service planning would only apply to site costs since these come out of the Forest Service funds.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
		X_1, site 1	X_2, site 1	X_1, site 2	X_2, site 2	Y_1, site 1	Y_2, site 1	Y_1, site 2	Y_2, site 2	Σtrans.cost	Σsite cost	X_1	X_2	Y_1	Y_2	X_1'	X_1''	X_1'''	X_2'	X_2''	X_2'''	Y_1'	Y_1''	Y_1'''	Y_2'	Y_2''	Y_2'''	RHS	
1	trans. costs	t_1	t_2	t_3	t_4	t_5	t_6	t_7	t_8	-1																		=0	1
2	site costs	s_1	s_1	s_2	s_2	s_3	s_3	s_4	s_4		-1																	=0	2
3	budget const.									1	1																	$\leq B$	3
4	ΣX, orig. 1	1		1								-1																=0	4
5	ΣX, orig. 2		1		1								-1															=0	5
6	ΣY, orig. 1					1		1						-1														=0	6
7	ΣY, orig. 2						1		1						-1													=0	7
8	X_1 seg.											-1				1	1	1										=0	8
9	X_2 seg.												-1						1	1	1							=0	9
10	Y_1 seg.													-1								1	1	1				=0	10
11	Y_2 seg.														-1										1	1	1	=0	11
12	X_1'															1												$\leq K_1$	12
13	X_1''																1											$\leq K_2$	13
14	X_2'																		1									$\leq K_1$	14
15	X_2''																			1								$\leq K_2$	15
16	Y_1'																					1						$\leq K_1$	16
17	Y_2''																						1					$\leq K_2$	17
18	Y_2'																								1			$\leq K_1$	18
19	Y_2''																									1		$\leq K_2$	19
20	Obj.fun.									-1	-1					V'_{X_1}	V''_{X_1}	V'''_{X_1}	V'_{X_2}	V''_{X_2}	V'''_{X_2}	V'_{Y_1}	V''_{Y_1}	V'''_{Y_1}	V'_{Y_2}	V''_{Y_2}	V'''_{Y_2}	Max.	20

Figure 2. Structure of a Linear Programming Solution to the Recreation Allocation Problem.

It is expected that the site costs for a given visit to a proposed site will be the same for all origins.

Rows 4 through 7 total number of trips for each combination of origin and site type into columns 11 through 14. These totals will subsequently be the quantity demanded variable in the piece-wise approximated experience demand curves -- one for each origin and for each site (or experience type). If we had not made the assumption that each proposed site supports only one type of experience, then additional rows and columns would be necessary to total experiences of each type that occur at different sites into a total number of experiences for each origin and each experience type.

Rows 8 through 11 serve to split the number of trips from each origin to each proposed site into the three segments that piece-wise approximate the experience demand curve. Each segment is superscripted ', '', or ''', to denotefirst, second, and third segment of the experience demand curve. So, for example, the second segment of the quantity demanded in origin 2 for site type X, alternative site 1, is: X_{12}''.

Rows 12 through 19 set up the limits of the demand curve segments. In each case, the third segment (''') is unfettered -- it applies to all of the demand curve beyond the first two segments. The first segment of each demand curve applies to all quantities demanded between 0 and K_1. The second segment of each demand curve applies to all quantities demanded between K_1 and K_2. And, the third segment applies to all quantities demanded greater than K_2. These limits do not, of course, need to be the same for the different origins and site types as is depicted here for convenience. Since we will have a priori knowledge of the experience demand curves, setting segment boundaries so as to minimize approximation errors should present no problem.

Finally, Row 20 is the objective function to be maximized. The benefits (the V's) for each piece of each demand curve are totalled to arrive at total regional gross benefits from which regional site costs and regional travel costs are deducted. The objective function can thus be considered as maximization of net social benefits in the Paretian framework.

Obviously, any number of embellishments on this basic structure are possible. These would include additional constraints that reflect the limits of physical recreation productivity in the given region, the inclusion of a time element instead of the simple single-year basis, and the inclusion of other social costs such as that of personal equipment, education and information, land opportunity costs, etc. This basic structure should suffice, however, to demonstrate the potential of an operations research approach to efficiently planning for recreation at the regional level, employing the travel cost information that the previously described demand analysis should provide. In pragmatic applications, the model would need to be much larger than the demonstrative example presented here. The foreseeable size would by no means be prohibitive, however, given the present sophistication in linear programming solution procedures and matrix generators.

CONCLUSION

A number of techniques and analysis design improvements have been discussed above. The manner in which these techniques and improvements should be utilized in Forest Service planning has not yet been made clear, however. Through the MUSYA, RPA, NFMA, and supporting regulations, it is clear that planning must procede at the National, Regional, and Forest levels. Furthermore, supply and demand analysis, especially in the form of benefit-cost analysis will be necessary in some form at all of these levels. It seems rational that National and Regional planning should concentrate on budgetary allocations, leaving determination of land practices on specific land areas to the Forest level. Furthermore, the overall policies, goals, and decision criteria should be determined at the National level.

These different levels of decision making can be handled operationally through an approach such as that presented by Wong (1980). In brief, this approach would consist of 1) generating "optimum" Forest plans for different budget levels, 2) at the Regional level, determining an "optimal" allocation of funds to Forests for different regional budget levels, and 3) at the National level, determining an "optimal" allocation of funds between regions. "Optimal" would be defined by, among other things, economic efficiency criteria. This economic efficiency would, of course, relate to not only cost minimization, but also maximization of present-value net benefits.

It appears that benefit estimation can be most effectively implemented at the Regional level. This is particularly true of the improved travel cost approach described above which is a regional demand model. Since cost information is highly affected by local labor costs and especially land productivity,

this should generally be generated at the Forest level. Thus:

> Forest level cost-benefit analysis would use local cost figures and regional value indexes,
>
> Regional level cost-benefit analysis would use aggregated cost figures and regional value indexes, and
>
> National level cost-benefit analysis would use aggregated cost figures and aggregated value indexes.

The operations research recreation planning model would be useable after Regional or Forest budget determination, or with a number of budgetary levels in determining minimum cost estimates and maximum net benefit estimates. Similar models which concentrate on a single product have been previously developed (RangeRam, TimberRam, etc.).

It would seem that participation projections and facility capacity comparisons are most useful in National planning -- fulfilling RPA requirements. Thus, this analysis should probably be carried out at the National level. Regional breakdowns are also very important components of this work; however, since the projections are population-based, the regions must be large enough so that its population is recreating predominantly within the region's boundaries. This constraint, again, supports National-level participation projections.

In general, it should be clear that the procedures suggested here are imperfect and will involve estimation and in some cases, approximation. They have been described in a general context, thus adaptation and modification of these procedures to specific problems is both appropriate and necessary. The focus of this discussion has been on the demand side of the analysis, and further work is required concerning supply analysis -- especially

in terms of identifying opportunities for recreation facility enhancement. This is an area that is not conducive to rigorous analysis, and no real progress has been made in this direction through the course of this study. Otherwise, it is felt that the study has been generally successful. It is hoped that the suggested design improvements in this document will prove helpful to Forest Service analysts regardless of whether any or all of them are actually adopted. This is a very difficult area of analysis which is worthy of considerable effort in the future due to its importance in efficiently allocating the National Forest and related resources.

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